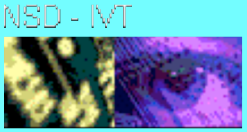
TOC

Starlight: a Visual Information System (VIS)

4th Workshop on Risk Analysis and Safety Performance Measurement in Aviation



Mike Blaine

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Battelle Memorial Institute

- Founded in 1928 at the direction of the will of Gordon Battelle
- Mission: For the betterment of mankind through technology
- Headquarters in Columbus, Ohio, USA
- ~ 1 billion USD in yearly revenues
- Three major business areas:
  - Contract research
  - Intellectual property commercialization
  - Laboratory management

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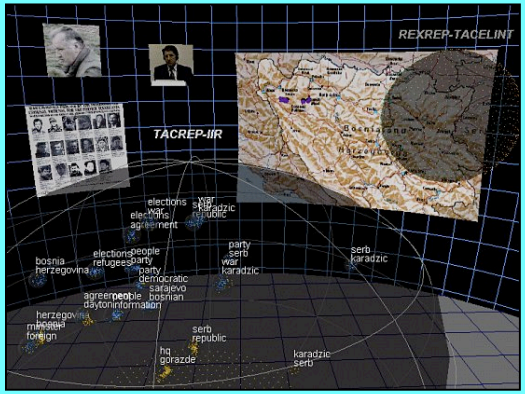
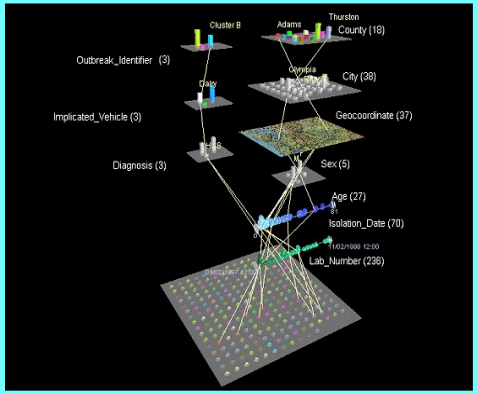
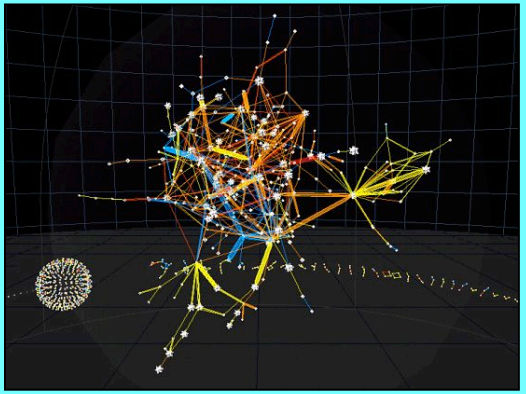
What Is Starlight?

A: It's a *Visible Information System* (VIS)







- Prototype example of a new class of information system
- Advanced information processing, management, and mining/analysis functionality coupled to a visualization-oriented user interface

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History & Evolution of Starlight

1995	First demonstration prototype (CIA ORD)
1997	Initial proof-of-concept prototype (v.1.0, USA INSCOM)
1998-99	v.1.0 prototype enhancements
2000-present	Sustained funding (v.2.0, USA INSCOM IDC)
2000	Advanced preprocessing functionality (DARPA)
2001	Network & Hierarchy displays (DCFL)
2001	Web harvesting (DOE SO-21)
2002	v.3.0 design and engineering (INSCOM IDC)
2002	Temporal data modeling & visualization (DCFL)
2002	Pattern recognition technologies (INSCOM IDC, DOJ)

Principle R&D Sponsors

US Army INSCOM IDC

DOD Computer Forensics Lab

DOE/NN-20, SO-21

DARPA

US Department of Justice

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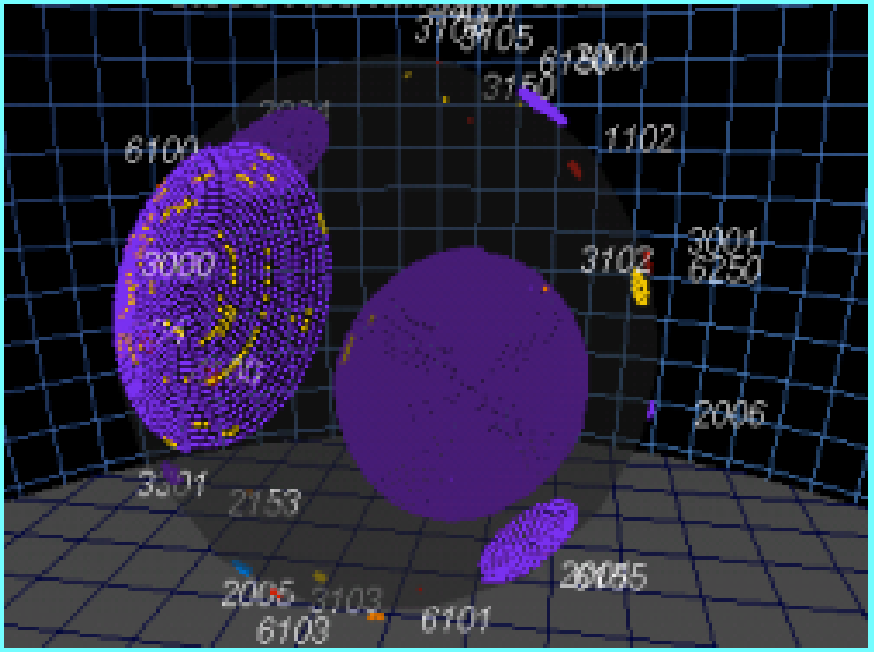
"To understand is to perceive patterns."
- Isaiah Berlin

"The soul never thinks without a picture."
- Aristotle

"Some people say that the network is the computer. We think that the display is the computer."
- Jen-Hsun Huang
CEO, Nvidia



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What Does It Do?

- Correlates information of disparate types & formats, in multiple ways
  - Unstructured and semi-structured text
  - Relational data
  - Spatial data
  - Multimedia information
- Graphically depicts correlation structures so that they can be visually intercompared

Key Goal:

➢ Support the concurrent visual analysis of large quantities of disparate information

4 Items	Rel.	event_DTG	event_location	event_type	highest_injury	activity	ac_make_model
RECORD:23	-	06/13/2002 0153	MINNEAPOLIS, MN, US	Incident	None	Business	B737
RECORD:320	-	07/07/2002 2130	CHICAGO, IL, US	Accident	None	Business	B737
RECORD:330	-	07/06/2002 2006	SALT, UT, US	Incident	None	Business	B737
RECORD:475	-	07/21/2002 2224	SALT, UT, US	Incident	None	Business	B737

ECORD:320

IDENTIFICATION

AC Registration #: 706SW **Make/Model:** B737

Description: 737-700, BBJ, C-40

Date: 07/07/2002 **Time:** 2130 **Event Type:** Accident

Highest Injury: None **Mid Air:** N **Missing:** N

Damage:

LOCATION

City: CHICAGO **State:** IL **Country:** US

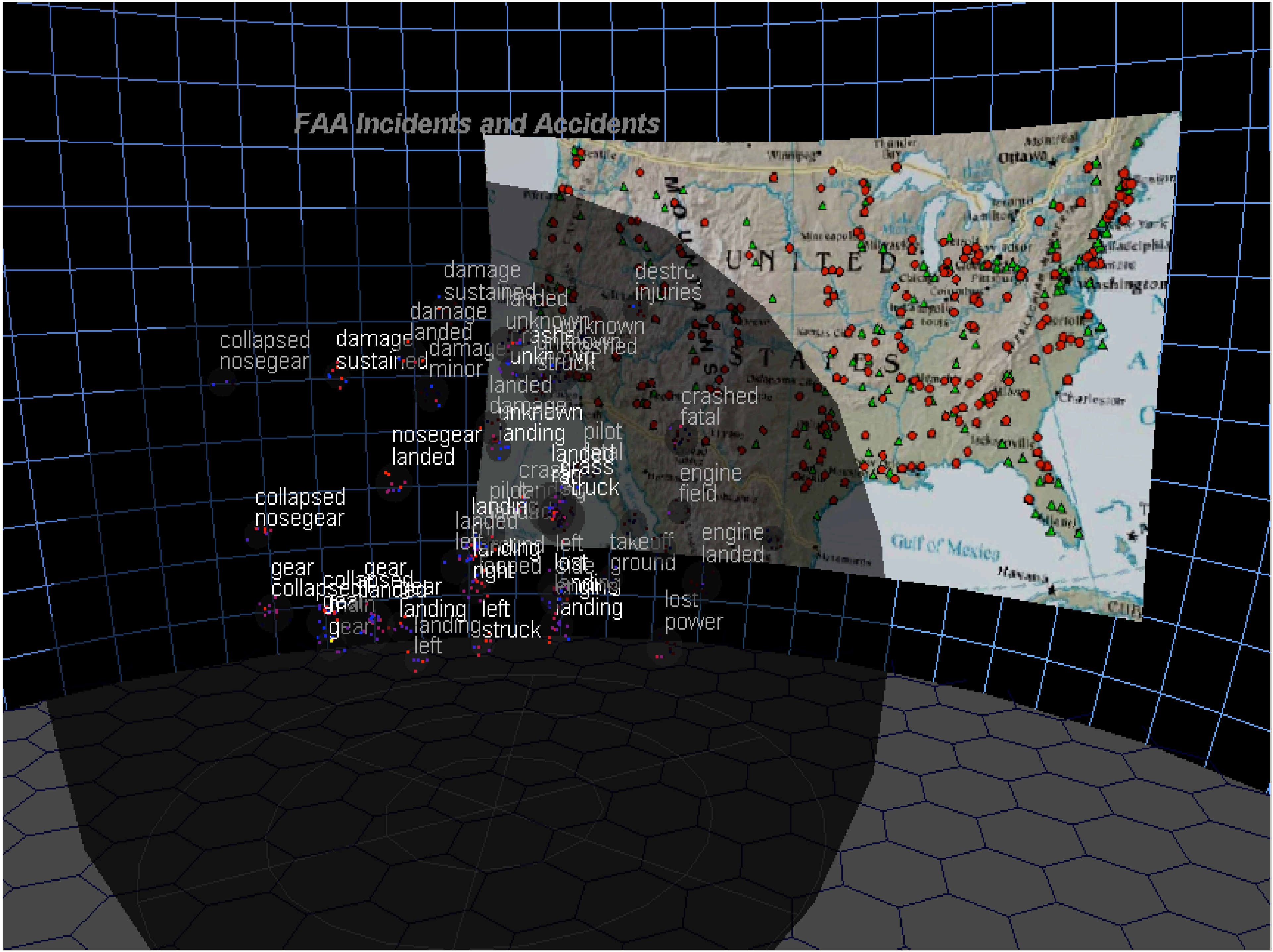
DESCRIPTION

SOUTHWEST AIRLINES FLIGHT 1544 , B737, DURING PUSH BACK TOW BAR SNAPPED, FLIGHT ATTENDANT INJURED AND TAKEN TO HOSPITAL, CHICAGO, IL

INJURY DATA

Total Fatalities: 0

	Number	Fatalities	Serious	Minor	Unknown
Crew	0	0	0	0	Y
Passengers	0	0	0	0	
Ground		0	0	0	


FAA Incidents and Accidents
collapsed nosegear
damage sustained
damage sustained
damage landed
nosegear landed
collapsed nosegear
crashed fatal
engine field
engine landed
takeoff ground
lost power
destroyed injuries
UNITED STATES
Gulf of Mexico

Why A New Approach?

- Information volume
- Information complexity
- Information dynamics
- Problem domain complexity
- High operational tempos
- User stress & ineffectiveness

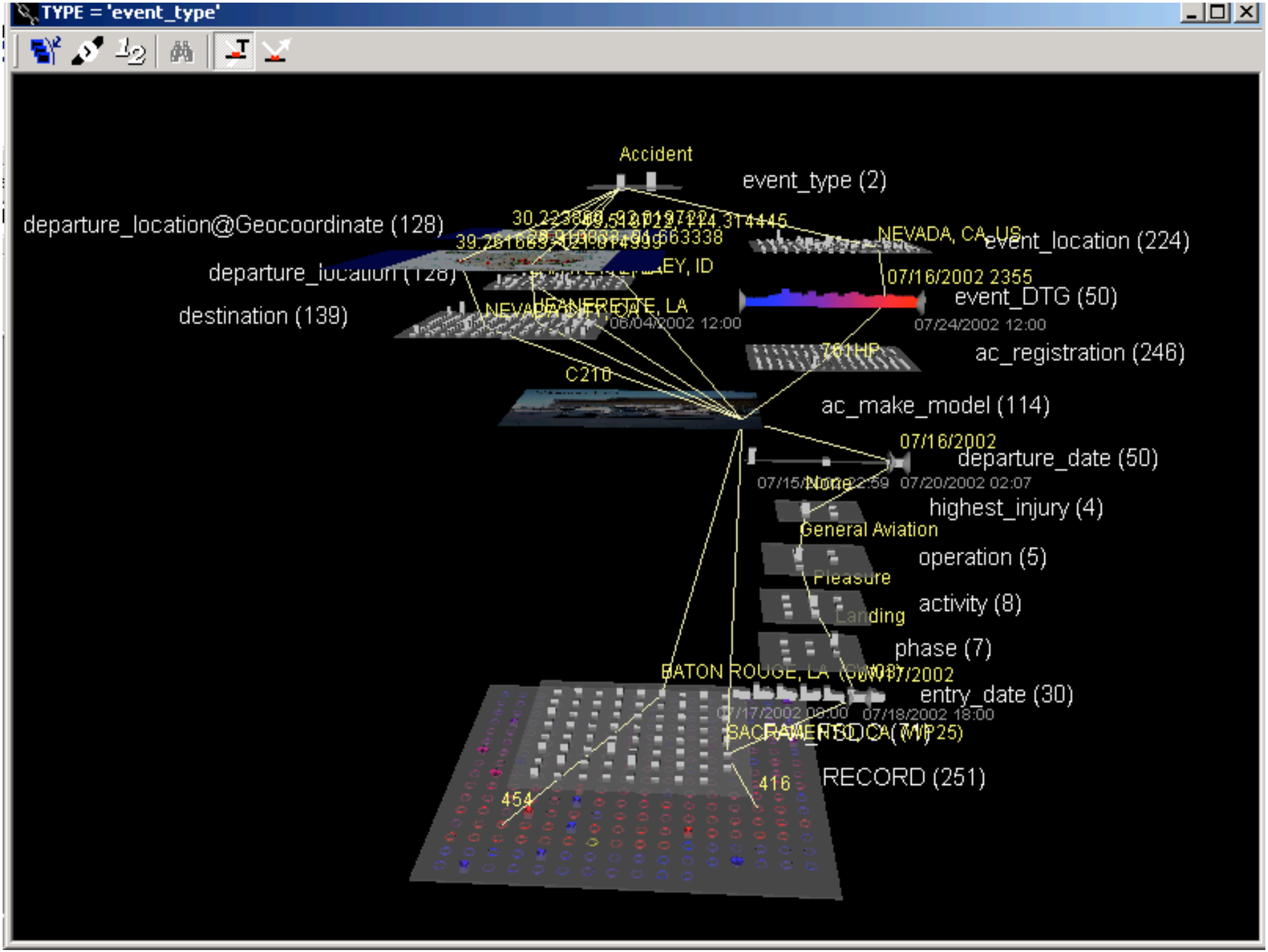
What Makes Starlight Different?

- Uniquely powerful information model
- Visualization-oriented user interface
- Powerful information engineering capabilities
- Integrated pattern recognition/data mining tools
- Concurrent analysis of disparate information
- Seamless transitions between analysis modes

The Nature of the Problem

- **Real-world safety problems are typically complex and multifaceted**

- Solving them commonly requires the complex integration of multiple information types
- This problem is compounded by the sheer volumes of information available
- Further compounded by the dynamic nature of many real-world problems, information reliability issues


TYPE = 'event_type'
Accident
event_type (2)
departure_location@Geocoordinate (128)
departure_location (128)
destination (139)
event_location (224)
NEVADA, CA, US
07/16/2002 2355
event_DTG (50)
07/24/2002 12:00
ac_registration (246)
761HP
C210
ac_make_model (114)
07/16/2002
departure_date (50)
07/20/2002 02:07
highest_injury (4)
None
General Aviation
operation (5)
Pleasure
activity (8)
Landing
phase (7)
entry_date (30)
07/18/2002 18:00
RECORD (251)
454
416

System Design Philosophy

- Model information closer to the way people do
- Generate graphical depictions of relationships among multiple pieces of information
- Enable investigation of multiple relationships simultaneously
- Enable seamless transitions between different analysis modes
- Enable inspection of patterns at multiple levels of abstraction
- Support visual pattern discovery with computational pattern recognition

The Starlight Approach

1. Convert information to a common format
2. Form meaningful “information objects”
3. “Enhance” the objects to increase their analytical value
4. Capture relationships among information objects
5. Graphically represent the modeled relationships so that they can be effectively compared
6. Provide cueing mechanisms to alert users to patterns of potential interest
7. Provide tools for communicating the results of analyses to decision makers

Software Demonstrations

- Not today
  - In D.C. or we will come to you
  - ASRS data for FAA / NTSB next

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In Conclusion

- Starlight is a Visual Information System
  - Displays data in 3 dimensions
  - Allows analysts to see relationships faster
- Developed by Pacific Northwest National Labs
  - GOTS tool / Companies need government sponsor
  - Shrink wrap in 12 to 18 months???
- Contact Mike Blaine for a Demo
  - Blainem@Battelle.org (703) 413-7241

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Are there any…

- ***Questions?***

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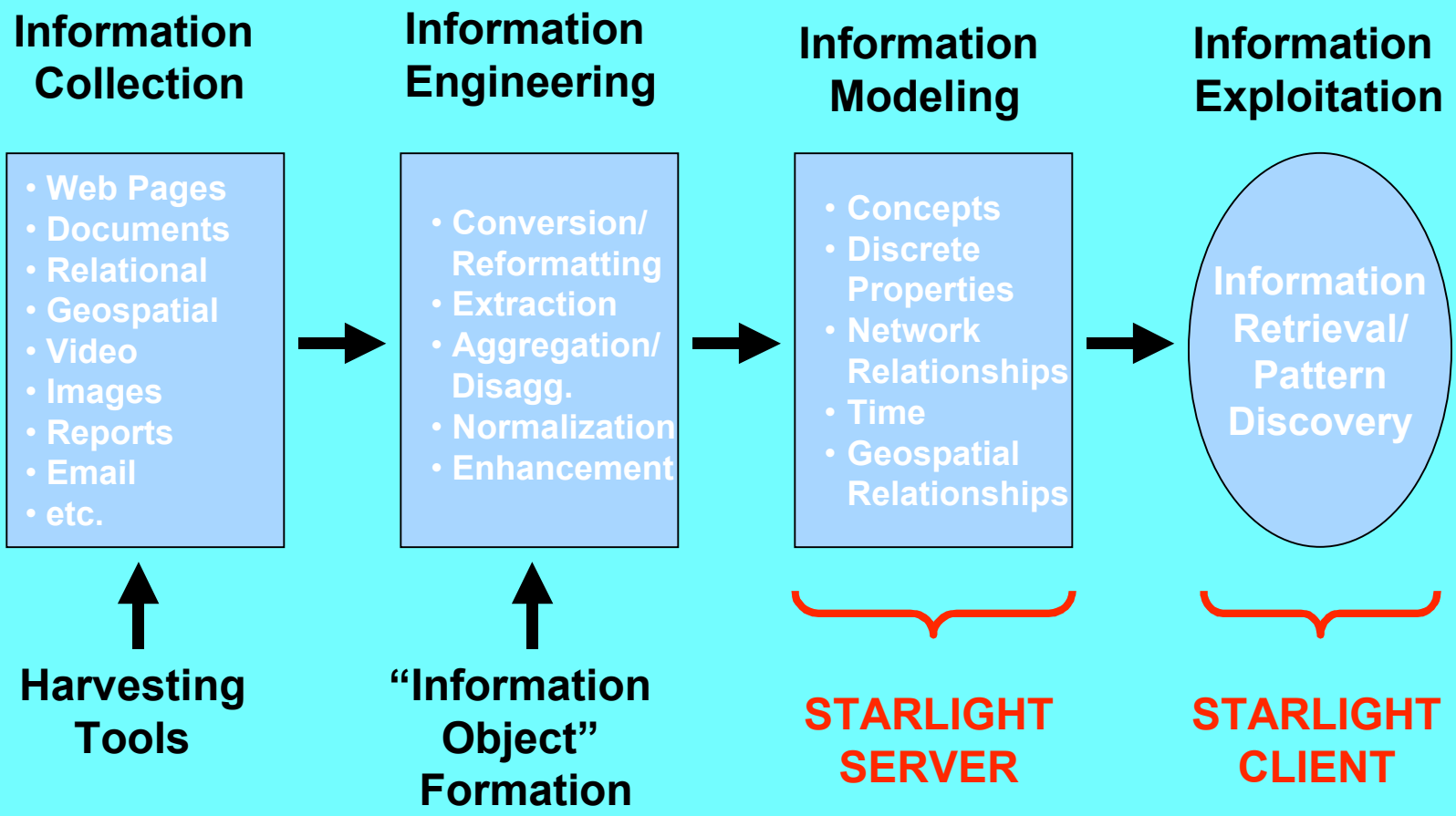
Four Aspects of Information Exploitation



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XML-based Information Integration

EMAIL 1

```
<?xml version="1.0" standalone="yes"?>
<!DOCTYPE EMAIL SYSTEM “email.dtd">

<EMAIL>
    <FROM>John Doe</FROM>
    <TO>Jack Parsons</TO>
    <CC/>
    <DATE>June 28, 2000 14:27 GMT</DATE>
    <SUBJECT>Our Friend</SUBJECT>
    < BODY >
        Have you heard from “F”? He was supposed to have
        reported back by now.
    </BODY>
</EMAIL>
```

EMAIL 2

```
<?xml version="1.0" standalone="yes"?>
<!DOCTYPE EMAIL SYSTEM “email.dtd">

<EMAIL>
    <FROM>Jack Parsons</FROM>
    <TO>John Doe</TO>
    <CC></CC>
    <DATE>June 28, 2000 17:44 GMT</DATE>
    <SUBJECT>Re: Our Friend</SUBJECT>
    < BODY >
        &gt;Have you heard from "F"? He was &gt;supposed to
        have reported back by now.

        Unfortunately, yes. He ran into some trouble in <EX_City
        Geocoordinate="45.340000,32.12000"
        Country="ITALY">Como</EX_City>, and lost the tablet.
        See if you can reach "R" tell him to request another
        sample from <EX_Org-Company>
        Tekhnaliksplit</EX_Org-Company>
    </BODY>
</EMAIL>
```

NEWS STORY 1

```
<?xml version="1.0" standalone="yes"?>
<!DOCTYPE NEWS_STORY SYSTEM “news.dtd">

<NEWS_STORY>
    <SOURCE>AP</SOURCE>
    <BYLINE>Jack Bateman</BYLINE>
    <DATE>June 27, 2000 11:14 GMT</DATE>
    <DATELINE>Como, Italy</DATELINE>
    <TITLE>Plutonium Smuggler Arrested in Como</TITLE>
    <BODY >
        A Swiss citizen, <EX_Person>Karl Friederich Federer</EX_Person>, was searched
        in his hotel in <EX_City Geocoordinate="45.340000,32.12000"
        Country="ITALY">Como</EX_City>, northern Italy, and a 'tablet' containing 0.2
        milligrams of plutonium was discovered. This tablet was apparently used to set
        gauges during work with fissionable materials and had been supplied by <EX_Org-
        Company>Tekhnaliksplit</EX_Org-Company> in <EX_City
        Geocoordinate="55.750000,37.583332" Country="RUSSIA"
        Standard_Name="RS02"> Moscow</EX_City>. Federer has been linked both to the
        <EX_Org-Misc>KGB</EX_Org-Misc> and the Russian Mafia. According to Federer,
        he had received the sample (and the order to go to <EX_Country
        Standard_Name="ITALY"> Italy</EX_Country>) in October in <EX_City
        Geocoordinate="47.266666,11.400000" Country="AUSTRIA"
        Admin_District="TIROL" Standard_Name="INNSBRUCK"> Innsbruck</EX_City>
        from <EX_Person>Peter Radochal</EX_Person>, an Austrian
    </BODY>
</NEWS_STORY>
```

- Network Relationship
- Temporal Relationship
- Conceptual Similarity
- Structured Property Co-occurrence

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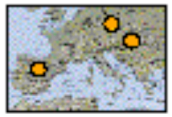
The Starlight Information Model

- **Hybrid model captures multiple types of relationships that may exist among arbitrary "information objects"**
- **Supports both information retrieval and comparison operations**

Relationship Type:	General Similarity	Explicit Reference	Field/Value Co-occurrence	Parent/Child	Spatial	Temporal
Model Type:	*Vector-space* 	*Network* 	*Multidimensional Index* 	*Hierarchical* 	*Spatial* 	*Ordinal Index*
Examples:	*Reports, articles, DB records*	*References & citations, hyperlinks*	*DB records, document metadata*	*File paths, taxonomies, IP addresses*	*Geolocations, CAD models*	*Event descriptions*

- ***Note that only the types of possible relationships are predefined; <u>not the contents of the objects themselves</u>.***
- ***This makes possible the integration and concurrent analysis of an unlimited variety of information types***

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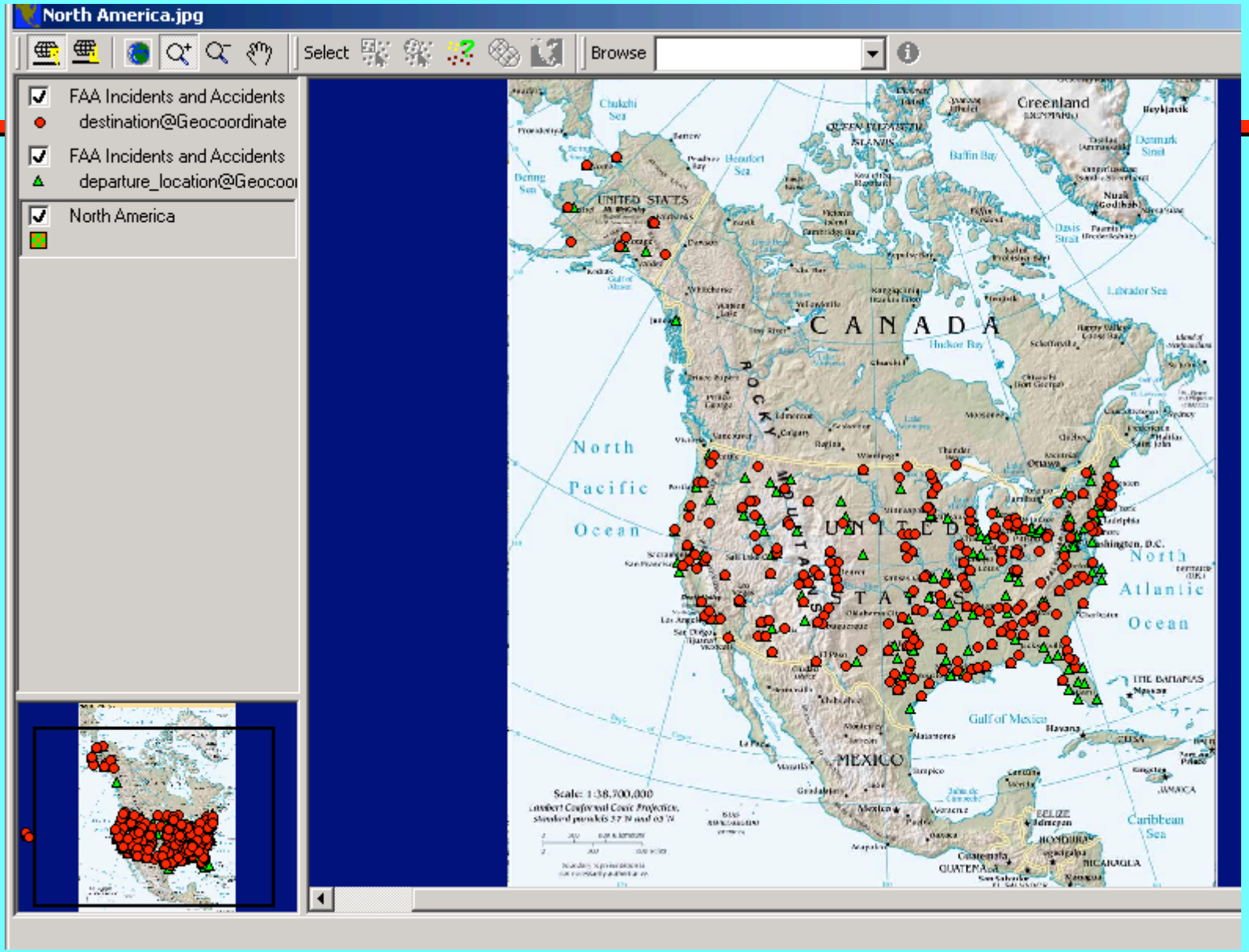
North America.jpg
Select
Browse
FAA Incidents and Accidents
destination@Geocoordinate
FAA Incidents and Accidents
departure_location@Geocoor
North America
Greenland
CANADA
UNITED STATES
MEXICO
North Pacific Ocean
North Atlantic Ocean
Gulf of Mexico
Caribbean Sea
Scale: 1:38,700,000

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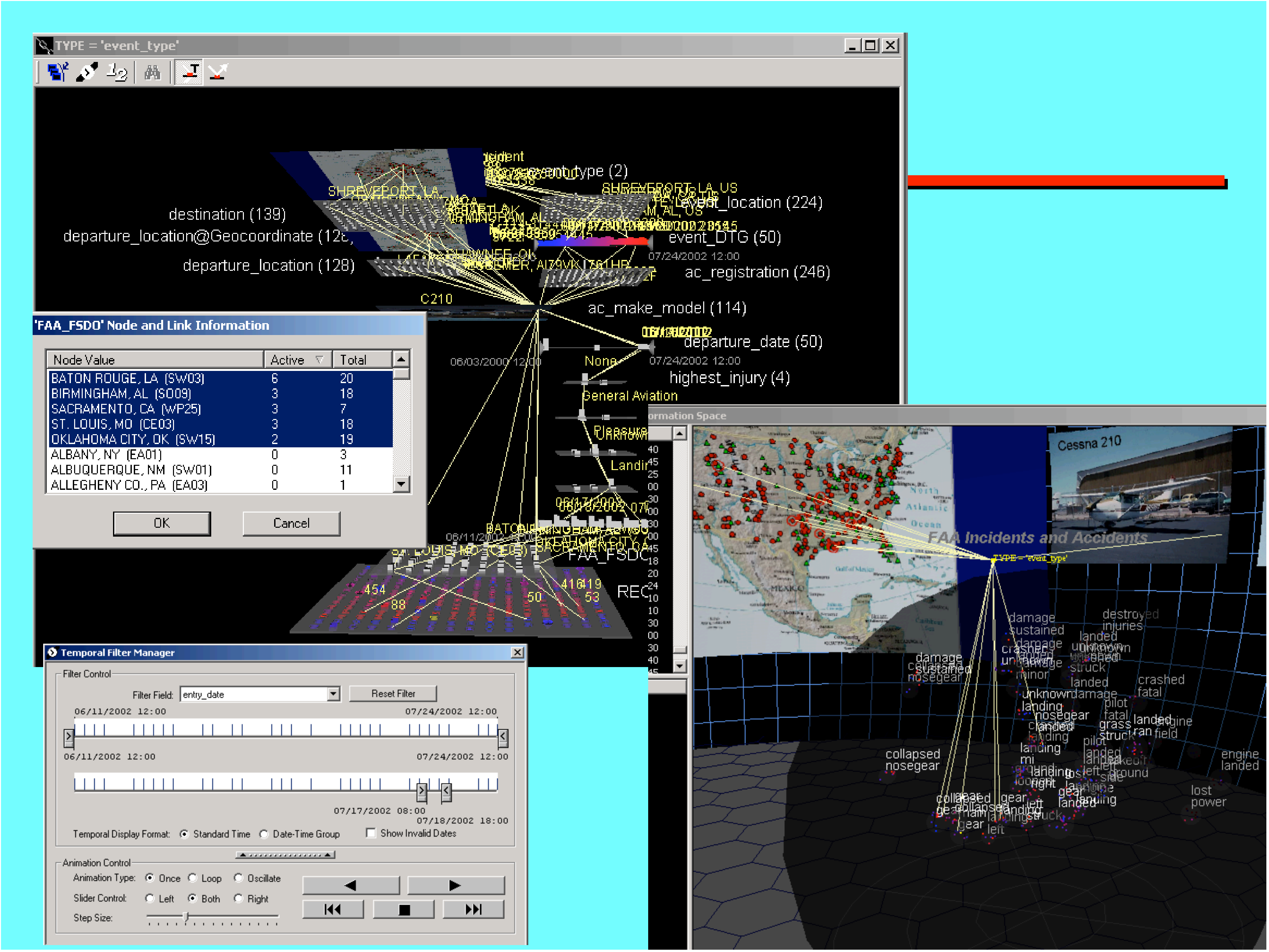
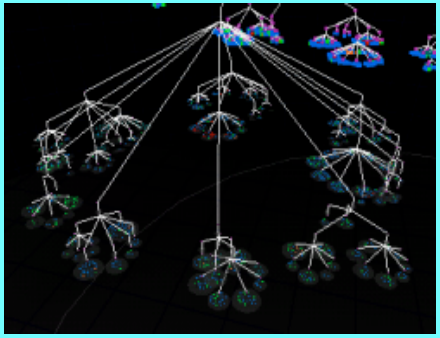
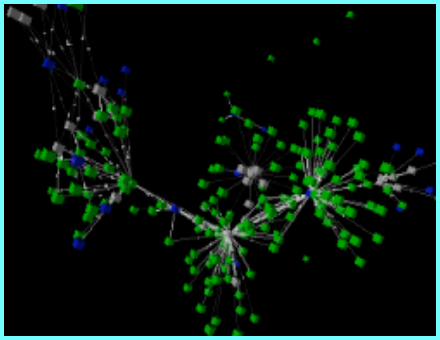


TYPE = 'event_type'
destination (139)
departure_location@Geocoordinate (128)
departure_location (128)
event_type (2)
event_location (224)
event_DTG (50)
07/24/2002 12:00
ac_registration (246)
C210
ac_make_model (114)
departure_date (50)
06/03/2000 12:00
None
07/24/2002 12:00
highest_injury (4)
General Aviation
'FAA_FSDO' Node and Link Information
Node Value
Active
Total
BATON ROUGE, LA (SW03) 6 20
BIRMINGHAM, AL (SO09) 3 18
SACRAMENTO, CA (WP25) 3 7
ST. LOUIS, MO (CE03) 3 18
OKLAHOMA CITY, OK (SW15) 2 19
ALBANY, NY (EA01) 0 3
ALBUQUERQUE, NM (SW01) 0 11
ALLEGHENY CO., PA (EA03) 0 1
OK
Cancel
Temporal Filter Manager
Filter Control
Filter Field:
entry_date
Reset Filter
06/11/2002 12:00
07/24/2002 12:00
06/11/2002 12:00
07/24/2002 12:00
07/17/2002 08:00
07/18/2002 18:00
Temporal Display Format:
Standard Time
Date-Time Group
Show Invalid Dates
Animation Control
Animation Type:
Once
Loop
Oscillate
Slider Control:
Left
Both
Right
Step Size:
Cessna 210
FAA Incidents and Accidents
TYPE = 'event_type'
damage
sustained
destroyed
injuries
landed
unknown
crashed
fatal
collapsed
nosegear
engine
landed
lost
power

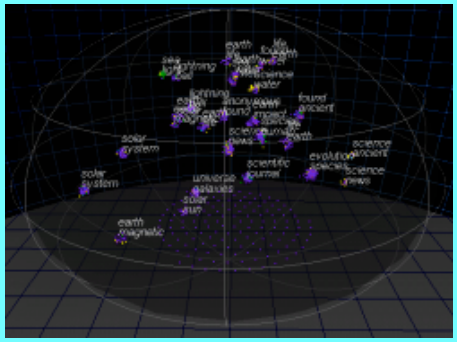
Starlight Global Visualizations



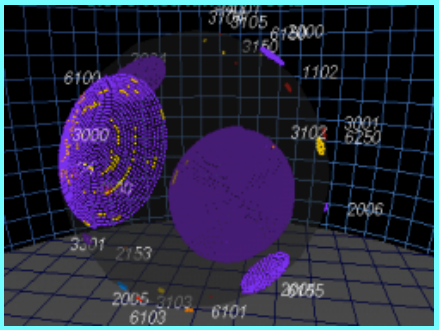
Hierarchical Relationships



Network Relationships



Text Similarity



Discrete Property Correlations

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